

## **Aptian-Albian coral faunas from the Sierra del Carche (Prebetic, Murcia, southern Spain)**

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Löser, H., Arias, C. & Vilas, L. 2015. Aptian-Albian coral faunas from the Sierra del Carche (Prebetic, Murcia, southern Spain). [Faunas de corales del Aptiense-Albiense de la Sierra del Carche (Prebético, Murcia, sur de España)]. *Spanish Journal of Palaeontology*, 30 (1), 43-64.

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*Manuscript received* 31 March 2014  
*Manuscript accepted* 02 September 2014

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### **ABSTRACT**

Three small coral faunas from the Early Aptian, Latest Aptian and Late Albian from a sedimentary section in the Sierra del Carche are described. A total of 17 species in 15 genera of the suborders *Amphiastraeina*, *Archeocaeniina*, *Faviina*, *Fungiina*, *Heteroceniina*, *Microsolenina*, and *Stylinina* are reported. One species in the genus *Heteropistophyllum* is described as new. The Early Aptian fauna encompasses six species, the Late Aptian fauna three species and the Late Albian fauna ten species. The three faunas do almost not share species. There are only colonial corals.

**Keywords:** Cretaceous, taxonomy, invertebrates.

### **RESUMEN**

Se describen tres pequeñas asociaciones de faunas de corales pertenecientes al Aptiense inferior, Aptiense terminal y Albiense superior de una sección de la Sierra del Carche. En total se han registrado 17 especies en 15 géneros de los subórdenes *Amphiastraeina*, *Archeocaeniina*, *Faviina*, *Fungiina*, *Heteroceniina*, *Microsolenina* y *Stylinina*. Se describe una nueva especie del género *Heteropistophyllum*. La fauna del Aptiense inferior abarca seis especies, la del Aptiense superior tres especies y la del Albiense terminal 10 especies. Las tres asociaciones faunísticas prácticamente no comparten especies. Solamente hay corales coloniales.

**Palabras clave:** Cretácico, taxonomía, invertebrados.

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## 1. INTRODUCTION

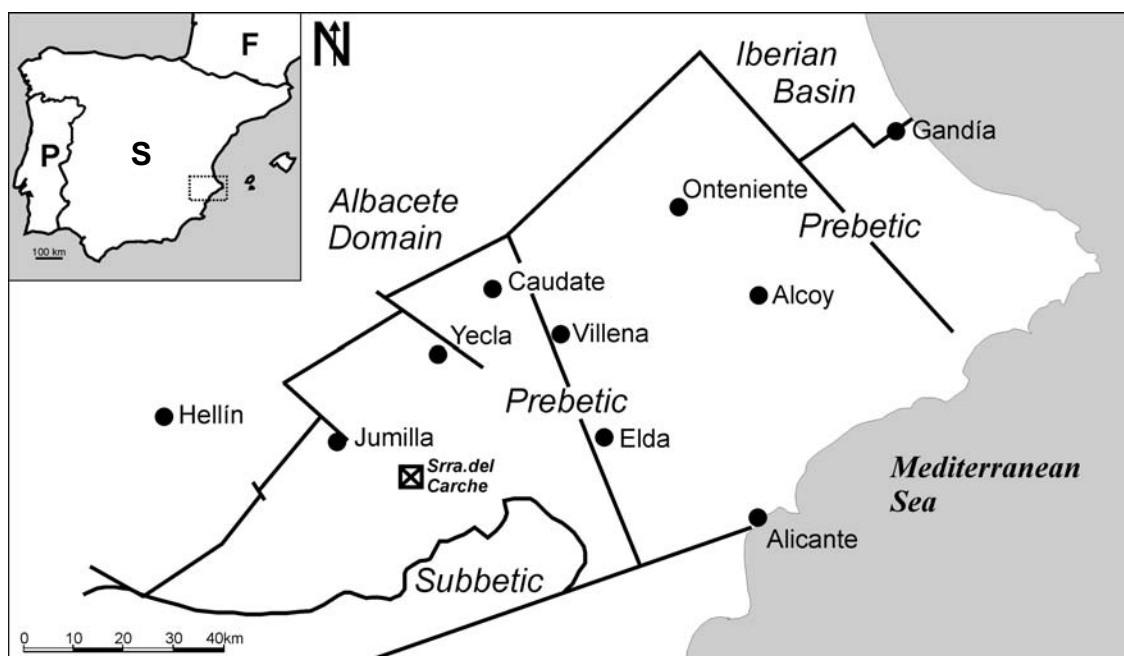
Numerous coral faunas are reported from the Early Cretaceous of the Iberian peninsula, but most of them are from Cantabria, the Pyrenees, and Catalonia. Coral faunas from the southern part of the Iberian Peninsula are poorly documented. Particularly, the paleontology of the Prebetic needs more investigation. The investigated area at the Sierra del Carche encompasses a large shallow marine sedimentary section that reaches from the Late Barremian to the Albian. Except for a first sedimentology and stratigraphic review (Masse *et al.*, 1992) not much is published about this area. This is also the case for the corals found in various levels. Although the material is not abundant and partly not in an optimal state of preservation it is worthy description because it encompasses various rare genera and shows interesting paleobiogeographic aspects.

## 2. STUDY AREA

### 2.1. Sierra del Carche

The Sierra del Carche is located in the South-East of Spain (Fig. 1) in the region known as the Jumilla-Yecla Plateau (Murcia). This area is characterized from a

geomorphological point of view by wide plain valleys of an average altitude of 600 m that separate long, narrow mountain ranges that run parallel to those valleys with altitudes above 900 m. Immediately SE of the Jumilla Plateau, the Sierra del Carche shows its large size, standing out from the nearest mountains. It has a slightly elongated shape following SSW-NNE, with a maximum height of 1,350 m. Two wide plains, practically flat, limit the mountain range to the NE and SE; the northern slope shows steep limestone escarpments while the stepped southern face ends in big alluvial fans from the Pliocene or ancient Quaternary ages. Located in the southwest end is an important diapir which cuts at an oblique angle the Cretaceous sediments that shape the massif core. Its northeastern boundary is a big strike-slip fault that separates from the Sierra de las Pansas. Geologically the Sierra del Carche is located in the outer zones of the Betic Cordillera, more precisely in the inner Prebetic (Martín-Chivelet *et al.*, 2002; Vilas *et al.*, 2004), where a sedimentary continuity between Jurassic and Cretaceous ages can be found. The sedimentation was controlled by active tectonic rifting during the Lower Cretaceous and passive margin in the rest of the sedimentation until the Upper Cretaceous period. Since then a compressional tectonic activity can be detected. This mountain range forms an overall complex anticline that comes originally from the filling of a half-graben, its further tectonic inversion and finally strike-slips tectonics. Stratigraphically, the lowest Cretaceous sediments correspond to the Upper Barremian, with a continuous record until and including the Paleocene, although there exists an important hiatus from the Lower



**Figure 1.** Geographical location of the Sierra del Carche and its position within the major divisions of the Eastern Prebetic (modified from Vilas *et al.*, 2004).

Cenomanian until the Coniacian that characterizes a palaeographic unit into the Prebetic (Martínez del Olmo *et al.*, 1982; Martín Chivelet, 1993; Vilas *et al.*, 1998, 2005).

## 2.2. The stratigraphic section

The mountain range is formed by the sedimentation of successive carbonate or mixed platforms. The Aptian sediments present a thickness of 550 m while the Albian and Lower Cenomanian sediments have a thickness of 350 m (Fig. 2). Regionally, these Cretaceous sediments have been divided into eleven tectosedimentary episodes or sequence sets (K1-K11), five of which correspond to the Lower Cretaceous (K1-K5) with a record of an inner marine platform sedimentation, and six (K6-K11) for the Upper Cretaceous, with a record that varies between hemipelagic sedimentation (dominant toward the top) with episodes of near-shore sediments (Vilas *et al.*, 1998, 2003; Chacón & Martín-Chivelet, 2003; Martín-Chivelet & Chacón, 2007).

The K4 megasequence has Lower Aptian age and is divided into three minor-order sequences (K4.1, K4.2 and K4.3). Corals from sample C1 correspond to the middle part of the K4.1, just below the *Iraqia simplex* unit. This sequence begins with siliciclastic sediments and ends with a shallow carbonate platform which contains well developed calcarenites under an upper layer of coral-bearing limestones that conform the top (as shown in section C1 of Fig. 2).

Samples C2 belongs to the K4.3 sequence, specifically to K4.3.2. It is enclosed between the levels containing *Orbitolinopsis reticulata* Moullade & Peybernès, 1978 and *Orbitolinopsis aquitanica* Schroeder & Poignant, 1964 in its lower part, and *Pseudochofatella cuvillieri* Deloffre, 1961 in its top. Nodular limestones with abundant corals, rudists and ostreids are supported by well-developed calcarenites (Fig. 2, C2). At the top of these limestones a sedimentary interruption can be seen, and above it siliciclastic sediments start to appear, as a base of the overlying sequence.

The coral samples C3 and C4 correspond to the top of unit K6, which belongs to the Upper Albian, and more specifically to the K6.2 sequence, with a thickness of 44 m. From a lithostratigraphic point of view, it belongs to the "Jumilla Formation" defined by Martín-Chivelet (1993, 1994).

The whole Jumilla Formation represents the beginning of the passive margin episode after the end of the "rifting" period of the Early Cretaceous. From a sedimentary evolution standpoint it corresponds to a transgressive period, expansive in the basin, which is formed in successive pulses. This sequence, with typical "Urgonian" characteristics, can be recognized throughout the mountain range although with no physical continuity due to the

significant postsedimentary tectonic evolution. Lateral facies changes are frequent. Over predominantly siliciclastic levels, a carbonate platform is installed with a powerful starting level of recrystallized and somewhat dolomitized limestones that probably are originally calcarenites. Above them there are three levels of limestone that form ridges, abundant in rudists, separated by nodular limestones with intense bioturbation, easy to erode. The nodular levels that separate these three limestone levels stand out for their ample bioturbation and a fauna of Radiolitidae and *Polyconites* at the lower level and colonial and solitary corals at the two upper levels (Fig. 2, C3, C4).

The sequence K6.2 ends in a ferruginous and bioturbated surface upon which the following sequence begins with terrigenous sediments alternating with brown grainstone type of limestone. The abundance of benthic foraminifers in this K6.2 sequence has assisted in dating this level as Upper Albian, but more precise it belongs to a typical biozone of benthic foraminifers that is characterized by the occurrence of *Neorbitolinopsis conulus* (Douvillé, 1912) and *Simplorbitolina conulus* (Schroeder, 1965). The Aptian and Albian sediments from the Carche Sierra were mainly dated by determining the abundant benthic foraminifera and rudists (Masse *et al.*, 1992).

## 3. MATERIALS AND METHODS

The material comes from four different levels with much variation in coral content (Fig. 2, Table 1). The amount of species is low in most levels, on one hand because of their rarity and the other because of their partly very poor state of preservation. The corals are only presented by small colonies. Most specimens were only superficially preserved and did not allow the preparation of thin sections. Because of this, in many cases only transversal, but no longitudinal thin sections could be prepared. Solitary corals were encountered in the field, but due to their poor state of preservation it was impossible to assign them even to a genus.

Coral slabs and thin sections were examined using a Zeiss STEMI 2000-C stereo microscope. Microphotographs for illustration purposes were obtained using a transparency scanner Epson Perfection V750-M Pro with an optical resolution of 6,400 dots per inch. Calicular dimensions were systematically measured. Values were calculated using the Palaeontological Database System PaleoTax, module PaleoTax/Measure (<http://www.paleotax.de/measure>). The procedure and statistical background are described in Löser (2012). The obtained morphometric values on the fossils were compared against those on specimens in World Wide fossil coral collections using a PaleoTax database (Löser, 2004) on Post-paleozoic corals and associated image database (with 21,000 specimens,

about 9,650 illustrated, located in the Estación Regional de Noroeste, Sonora, Mexico). The material is kept at the collection of the Bayerische Staatssammlungen für Paläontologie und Geologie, München (Germany; BSPG) under the numbers 2014 XV 1 to 36.

**Table 1.** List of coral species and the corresponding level.

Bed	C1	C2	C3	C4
Stratigraphy Species	Early Aptian	Early Late Aptian	Late Albian	
<i>Actinaraea</i> sp.				X
<i>Amphiastrea</i> sp.	X			
<i>Astraeofungia</i> sp.			X	X
<i>Camptodocis</i> sp.	X			
<i>Cryptocoenia almerai</i>				X
<i>Cryptocoenia</i> sp.				X
<i>Dimorpharaea</i> sp.	X			
<i>Dimorphastrea</i> sp.				X
<i>Diplogyra casanovai</i>	X			
<i>Diplogyra lamellosa</i>		X		
<i>Heteropistophyllum carchensis</i> n. sp.		X		
<i>Ovalastrea picteti</i>			X	
<i>Placocolumastrea gortanii</i>				X
<i>Pleurocoenia aprutina</i>	X			
<i>Silingastraea shimoheiensis</i>	X	X	X	
<i>Stelidioseris cornuelli</i>				X
<i>Stylina inwaldensis</i>				X

#### 4. SYSTEMATIC PALAEOLOGY

Collection abbreviations are as follows:

BSPG, Bayerische Staatssammlung für Paläontologie und Geologie, München, Germany;

ERNO, Instituto de Geología, Estación Regional de Noroeste, Universidad Nacional Autónoma de México, Hermosillo, Mexico;

FSL, Université Claude Bernard, Institut de Géologie, Lyon, France;

GSUB, Geologisch-Paläontologisches Institut Bremen, Germany;

IGM, Instituto de Geología, Universidad Nacional Autónoma de México, Mexico City, Mexico;

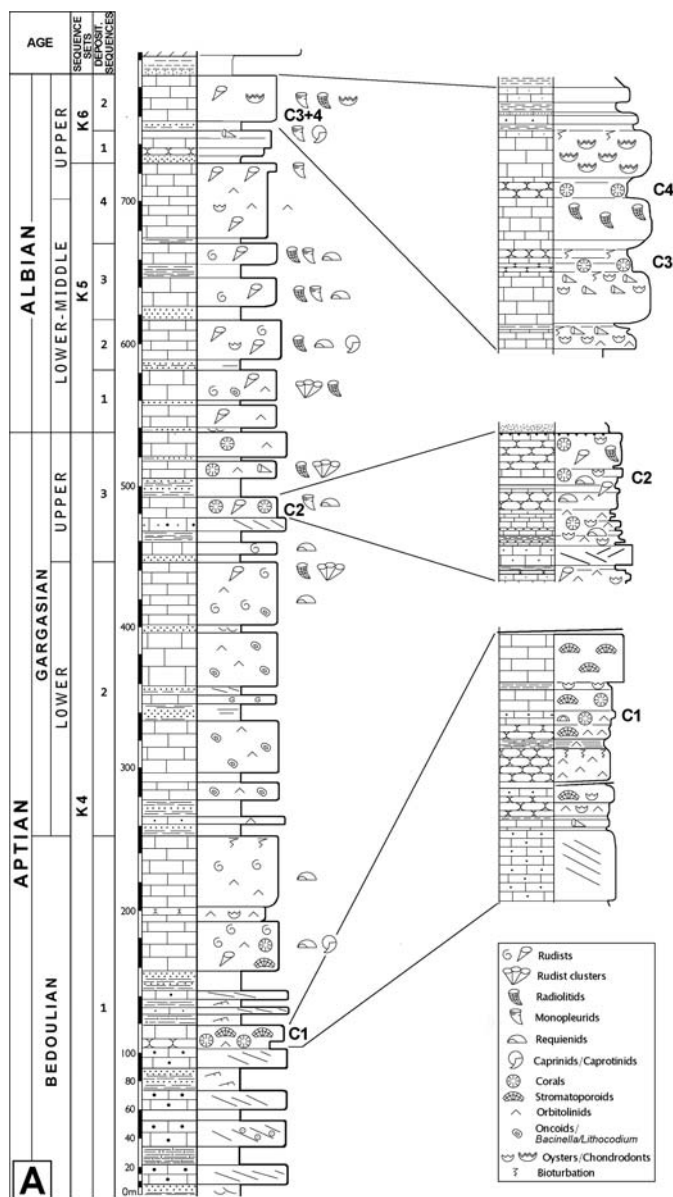
MB, Museum für Naturkunde der Humboldt-Universität, Berlin, Germany;

MGSB, Museo Geológico del Seminario de Barcelona, Spain;

SNSD-MMG, Senckenberg Naturhistorische Sammlungen Dresden, Museum für Mineralogie und Geologie, Dresden, Germany;

TUM, The Tohoku University Museum, Sendai, Japan;

ZSH, Zumsteinhaus, Kempten, Germany.



**Figure 2.** General column of Aptian and Albian sediments from Sierra del Carche and details of the sections where coral samples described in this paper were collected.

The following abbreviations are used describing the dimensions of the corals:

- c max, larger outer calicular diameter;
- c min, smaller outer calicular diameter;
- ccd, distance between calicular centres;
- cdw, distance between calicular centres within calicular series;
- cl, calicular diameter (calicular pit);
- cl max, large lumen;
- cl min, small lumen;
- crd, distance of calicular series;
- crw, width of calicular series;
- s, number of radial elements in adult calices;
- sd, density of radial elements.

The abbreviations used in the synonymy lists follow Matthews (1973):

- \*, earliest valid publication of the species name;  
v, the specimen was observed by the first author.

Suborder AMPHIASTRAEINA Alloiteau, 1952  
Family **Amphiastreaeidae** Ogilvie, 1897  
*Amphiastrea* Etallon, 1859

**Type species.** *Amphiastrea basaltiformis* Etallon, 1859.

*Amphiastrea* sp.  
(Figs 3a-c)

**Material.** BSPG 2014 XV 1; 2 thin sections.

#### Dimensions.

(2014 XV 1)	n	min-max	$\mu$	s	cv	$\mu \pm s$
cl min	30	1.04-1.49	1.24	0.12	10.0	1.12-1.37
cl max	30	1.67-2.26	2.01	0.17	8.7	1.83-2.19
ccd	20	1.78-2.67	2.26	0.26	11.5	2.00-2.52
s	7	22-33	26.42	3.69	13.9	23-30

**Description.** Cerioid colony. Calicular outline irregular polygonal. Septa compact. Microstructure of septa unknown. Septa in cross section slightly thicker close to the wall, becoming slightly thinner towards the centre. Symmetry of septa bilateral. Cycles of septa irregular, but size orders can be distinguished. Septal generations differ in length and thickness. First septal generation reaches through the centre of the calice, later generations are subsequently shorter. Septa not connected to each other. About three to five main septa present, that are longer than all other septa. Septal distal margin unknown, lateral face unknown, inner margin slightly swollen in places. Pali or paliform lobes absent, lonsdaloid septa, costae, synapticalae and columella absent. Endotheca consists of central tabulae and lateral dissepiments. Wall present, compact, probably trabecular. No marginarium (probably not visible due to the poor preservation). Budding intracalicular, marginal.

**Remarks.** The specimen presents very small dimensions and cannot be compared to any existing species. Small dimensions are also shown by *Amphiastrea paronai* Prever, 1909 and *Amphiastrea gracilis* Koby, 1888, but their calicular dimensions are still larger. Unfortunately, the poor state of preservation of the present material does not allow the description of a new species.

**Occurrence.** Sierra del Carche, Early Aptian, bed C1.

Suborder ARCHEOCAENIINA Alloiteau, 1952  
Family **Actinastraeidae** Alloiteau, 1952  
*Stelidioseris* Tomes, 1893

**Type species.** *Stelidioseris gibbosa* Tomes, 1893.

*Stelidioseris cornueli* (Orbigny, 1850)  
(Figs 3d-e)

**Material.** BSPG 2014 XV 2; 1 thin section.

#### Synonymy.

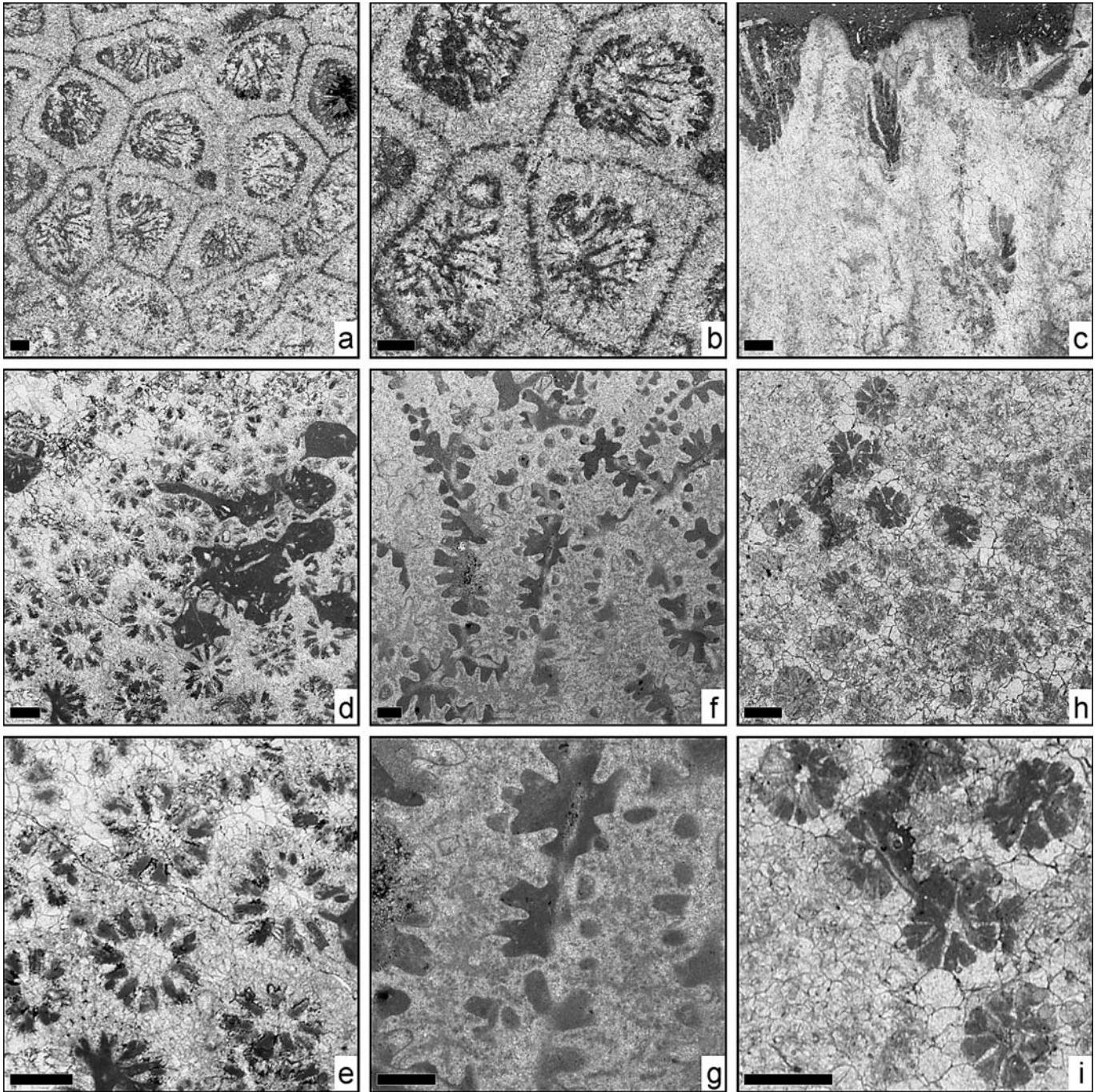
- \* 1850 *Astrocoenia Cornueliana*; Orbigny, (2), p. 92  
v 1870 *Astrocoenia decaphylla*; Duncan, p. 29, Pl. 11, Figs. 1-6  
v 1935 *Astrocoenia Cornueliana* d'Orb.; Cottreau, Pl. 74, Figs. 6-7  
v 1936 *Astrocoenia pseudominima* Koby 1896; Hackemesser, p. 71, Pl. 7, Fig. 14  
v 2009 *Actinastraea minima* (de Fromentel, 1857); Löser et al., p. 337, Fig. 2.9  
v 2013c *Actinastraea minima* (de Fromentel, 1857); Löser et al., p. 44, Pl. 1, Figs. 3-4

#### Dimensions.

(2014 XV 2)	n	min-max	$\mu$	s	cv	$\mu \pm s$
cl min	22	1.07-1.52	1.34	0.13	10.0	1.21-1.48
ccd	20	1.60-2.37	1.93	0.23	12.0	1.69-2.16
s	10+10					

**Description.** Plocoid colony. Calicular outline circular to slightly elliptical. Septa compact, in cross section thick close to the wall, slightly thinner towards the centre. Septa of the first cycle with swellings (renflements). Symmetry of septa radial and regularly decamerall. Cycles of septa regular. Septal cycles differ in length and thickness. First septal cycle reaches to the centre of the calice, the second cycle is much shorter. Septa of the second cycle occasionally attached to those of the first cycle. Septal distal margin unknown, lateral face with fine thorns. Pali or paliform lobes absent. All septa of the first cycle are attached to the columella. Costae hardly present, confluent leaving regular small intercalicular spaces (lacunes). Synapticalae absent. Columella styliiform. Endotheca unknown. Wall compact, septothecal. Coenosteum very narrow, consists of costae. Budding intracalicular.

**Remarks.** The syntypes of *Astrocoenia cornueliana* and *Astrocoenia minima* Fromentel, 1857 were recently found at the MNHN (Paris). The latter species belongs



**Figure 3.** **a-c)** *Amphiastrea* sp. (BSPG 2014 XV 1); **(a)** transversal thin section; **(b)** transversal thin section, detail; **(c)** oblique thin section. **d-e)** *Stelidioseris cornuelli* (Orbigny, 1850), (BSPG 2014 XV 2); **(d)** transversal thin section; **(e)** transversal thin section, detail. **f-g)** *Diplogyra casanovai* (Reig Oriol, 1994), (BSPG2014 XV 4); **(f)** transversal thin section; **(g)** transversal thin section, detail. **h-i)** *Styliina inwaldensis* (Ogilvie, 1897), (BSPG 2014 XV 36); **(h)** transversal thin section; **(i)** transversal thin section, detail. Scale bar 1mm.

to the genus *Holocoenia* and therefore not applied to *Stelidioseris* samples.

**Occurrence.** Sierra del Carche, Late Albian, bed C4.

**Other occurrences.** Cretaceous of Greece (Fokída) Kiona massif, Panourgias. Hauterivian of Jamaica (Saint

Catharine) Benbow Inlier, Copper. Early Hauterivian (Radiatus zone) of France (Haute-Marne) Saint Dizier, France (Yonne) Chenay, France (Yonne) Fontenoy, France (Yonne) Gy-l'Évêque, France (Yonne) Leugny, France (Yonne) Saint-Sauveur, France (Yonne) Venoy. Early to Middle Albian (Mammillatum - Lautus zone) of Greece (Viotía) Levadia, Agia Barbara (ERNO L-5386). UK

(Devonshire) Exeter, Haldon Hill. Middle Cenomanian of Germany (Bayern) Roßstein-Almen.

Suborder FAVIINA Vaughan & Wells, 1943  
Family **Columastraecidae** Alloiteau, 1952  
*Placocolumastrea* Reig Oriol, 1989

**Type species.** *Placocolumastrea torallolensis* Reig Oriol, 1989.

*Placocolumastrea gortanii* (Prever, 1909)  
(Figs 4a-c)

**Material.** BSPG 2014 XV 3; 2 thin sections.

#### Synonymy.

\*v 1909 *Ulastraea Gortanii*; Prever, p. 91, Pl. 5, Figs. 6, 7  
v 1926 *Astrocoenia asteriscus* Weissermel; Dietrich, p. 96  
v 1926 *Phyllocoenia* sp.; Dietrich, p. 67, Pl. 7, Fig. 1  
v 1932 *Stephanocoenia* (?) *guadalupae* Wells, n.sp.; Wells, p. 235, Pl. 32, Figs. 8, 9, Pl. 39, Fig. 3  
v 2013 ?*Placocolumastrea gortanii* (Prever, 1909); Löser, p. 8, Figs. 3j-l

#### Dimensions.

(2014 XV 3)	n	min-max	$\mu$	s	cv	$\mu \pm s$
cl min	20	2.02-2.49	2.27	0.13	5.9	2.14-2.41
ccd	20	2.31-3.59	2.80	0.36	12.8	2.44-3.16
s	24					

**Description.** Plocoid colony. Calicular outline circular. Septa compact, in cross section slightly thicker close to the wall, becoming slightly thinner towards the centre. Symmetry of septa radial and regularly hexameral. Cycles of septa regular. Septal cycles differ in length and thickness. First two septal cycles reach 40 % of the calicular diameter, the third cycle is shorter. Septa of the first cycle occasionally connected to each other in the centre of the calice. Septal distal margin unknown, lateral face occasionally with medium size thorns, inner margin slightly swollen in places. Paliform lobes on the first cycle. Some septa may be attached to the columella. Costae present but short, sub-confluent to non-confluent. Synapticulae absent. Columella lamellar. Endotheca consists of tabulae. Wall sub-compact, parathecal. Coenosteum narrow, consists of costae and exothecal dissepiments. Budding extracalicular.

**Occurrence.** Sierra del Carche, Late Albian, bed C4.

**Other occurrences.** Late Valanginian to Early Aptian of Tanzania (Tanganyika, Mtwara) Likonde Kitutu plateau, Litshihu plateau, Munimbira. Late Barremian to Early Aptian (Sartousi - Weissi zone) of Germany (Bayern) Allgäuer Helvetikum, Falkenberg (ZSH H-KU 793). Late Barremian to Early Aptian (Lenticularis zone) of Mexico (Sonora) Municipio Ures, Cerro de Oro (ERNO L-4321). Early Aptian of Egypt (Shebh Gezirat Sena) Maghara Mt, SE Mansour (GSUB SM01). Italy (Abruzzi, L'Aquila) Monti d'Ocre. Early Aptian (Weissi - Furcata zone) of Tanzania (Tanganyika, Mtwara) Nambawala plateau, Pilepile. Late Aptian (Jacobi zone) of USA (Texas) Comal County, Guadalupe River, Demijohn Bend. Early Albian of Mexico (Sonora) Municipio Ures, Cerro de Oro (ERNO L-4927). Early Albian (Mammillatum zone) of France (Aude) Padern, SE Le Crès. Middle Albian of Mexico (Sonora) Municipio San Pedro de la Cueva, Tepache, Lampazos area (ERNO 2189).

Family **Eugyridae** Duncan, 1884  
*Diplogyra* Eguchi, 1936

**Type species.** *Diplogyra lamellosa* Eguchi, 1936.

*Diplogyra casanovai* (Reig Oriol, 1994)  
(Figs 3f-g)

**Material.** BSPG 2014 XV 4; 1 thin section.

#### Synonymy.

\*v 1994 *Eugyra casanovai* n. sp.; Reig Oriol, p. 34, Pl. 1, Fig. b, Pl. 2, Fig. a  
v 2013b *Diplogyra casanovai* (Reig Oriol, 1994); Löser *et al.*, p. 199, Figs. 3b-c [here more detailed synonymy and occurrence data]

#### Dimensions.

(2014 XV 4)	n	min-max	$\mu$	s	cv	$\mu \pm s$
crw	20	0.83-1.47	1.12	0.19	17.1	0.93-1.31
crd	11	2.03-2.65	2.36	0.23	10.0	2.13-2.60
sd	10/5mm					

**Description.** Meandroid colony. Calicular rows short. Calices indistinct. Septa compact, in cross section thicker close to the wall, thinner towards the centre. Symmetry of septa irregular, but two size orders can be distinguished that differ in length and thickness. First septal generation reaches 40 % of the calicular diameter, the second generation is shorter. Septa not connected to each other. Septal distal margin unknown, lateral face smooth (probably due to preservation), inner margin smooth. Pali or paliform

lobes absent. Costae present, non-confluent. Synapticulae absent. Columella absent. Endotheca unknown. Wall compact, parathecal. Coenosteum medium broad, consists probably of costae and exothecal dissepiments. Budding intracalicular, polystomodeal.

**Occurrence.** Sierra del Carche, Early Aptian, bed C1.

**Other occurrences.** See Löser *et al.* (2013b).

*Diplogyra lamellosa* Eguchi, 1936  
(Figs 4d-f)

**Material.** BSPG 2014 XV 5; 2 thin sections.

**Synonymy.**

\*v 1936 *Diplogyra lamellosa*; Eguchi, p. 70, Figs. 3, 3 a  
v 1951 *Diplogyra lamellosa* Eguchi; Eguchi, p. 12  
v 1971 *Diplogyra lamellosa eguchii* n. subsp.;  
Morycowa, p. 81, Text-Fig. 25, Pl. 15, Fig. 1, Pl. 23, Fig. 2  
1985 *Diplogyra subplanotabulata* Sikh., sp. nov.;  
Sikharulidze, p. 32, Pl. 15, Fig. 2  
v 2003 *Pseudomyriophyllia carpathica* Morycowa,  
1971; Baron-Szabo & González León, p. 198, Fig. 5H

#### Dimensions.

(2014 XV 5)	n	min-max	$\mu$	s	cv	$\mu \pm s$
crw	15	1.57-2.35	1.96	0.24	12.4	1.71-2.20
crd	10	2.90-3.48	3.14	0.21	6.7	2.93-3.35
sd	10/5mm					

**Description.** Meandroid colony. Calicular rows long and sinuous. Calices indistinct. Septa compact, in cross section thicker close to the wall, thinner towards the centre. Symmetry of septa irregular, but two size orders can be distinguished that differ in length and thickness. First septal generation reaches 35 % of the calicular diameter, the second generations is shorter. Septa not connected to each other. Septal distal margin unknown, lateral face rarely with medium size thorns, inner margin smooth. Pali or paliform lobes absent. Costae present, confluent. Synapticulae and columella absent. Endotheca consists of tabulae. Wall compact, parathecal. Coenosteum medium broad, consists of costae and exothecal dissepiments. Budding intracalicular, polystomodeal.

**Occurrence.** Sierra del Carche, early Late Aptian, bed C2.

**Other occurrences.** Early Barremian of Georgia (Kartli) Ali. Barremian to Early Aptian of Romania

(Suceava) Pojorîta area, Cîmpulung-Moldovenesc, Pietrule Albe. Late Barremian to Early Aptian (Lenticularis zone) of Mexico (Sonora) Municipio Ures, Cerro de Oro. Aptian of Mexico (Puebla) San Juan Raya (IGM R10120). Early Aptian of Greece (Viotia) Arachova (BSPG 2003 XX 5504). Latest Aptian of Japan (Iwate-ken) Shimohei-gun, Tanohata-mura, Haibe and Hiraiga. Early Albian of Mexico (Sonora) Municipio Naco, quarry E Naco (ERNO L-4959).

Family **Placosmiliidae** Duncan, 1884

*Silingastraea* Liao, 1982

**Type species.** *Silingastraea xainzaensis* Liao, 1982.

*Silingastraea shimoheiensis* (Eguchi, 1951)  
(Figs 4g-i)

**Material.** BSPG 2014 XV 6 - 10; 3 thin sections.

**Synonymy.**

\*v 1951 *Thigmastrea* ? *shimoheiensis* Eguchi, n.sp.;  
Eguchi, p. 14, Pl. 4, Figs. 1, 2

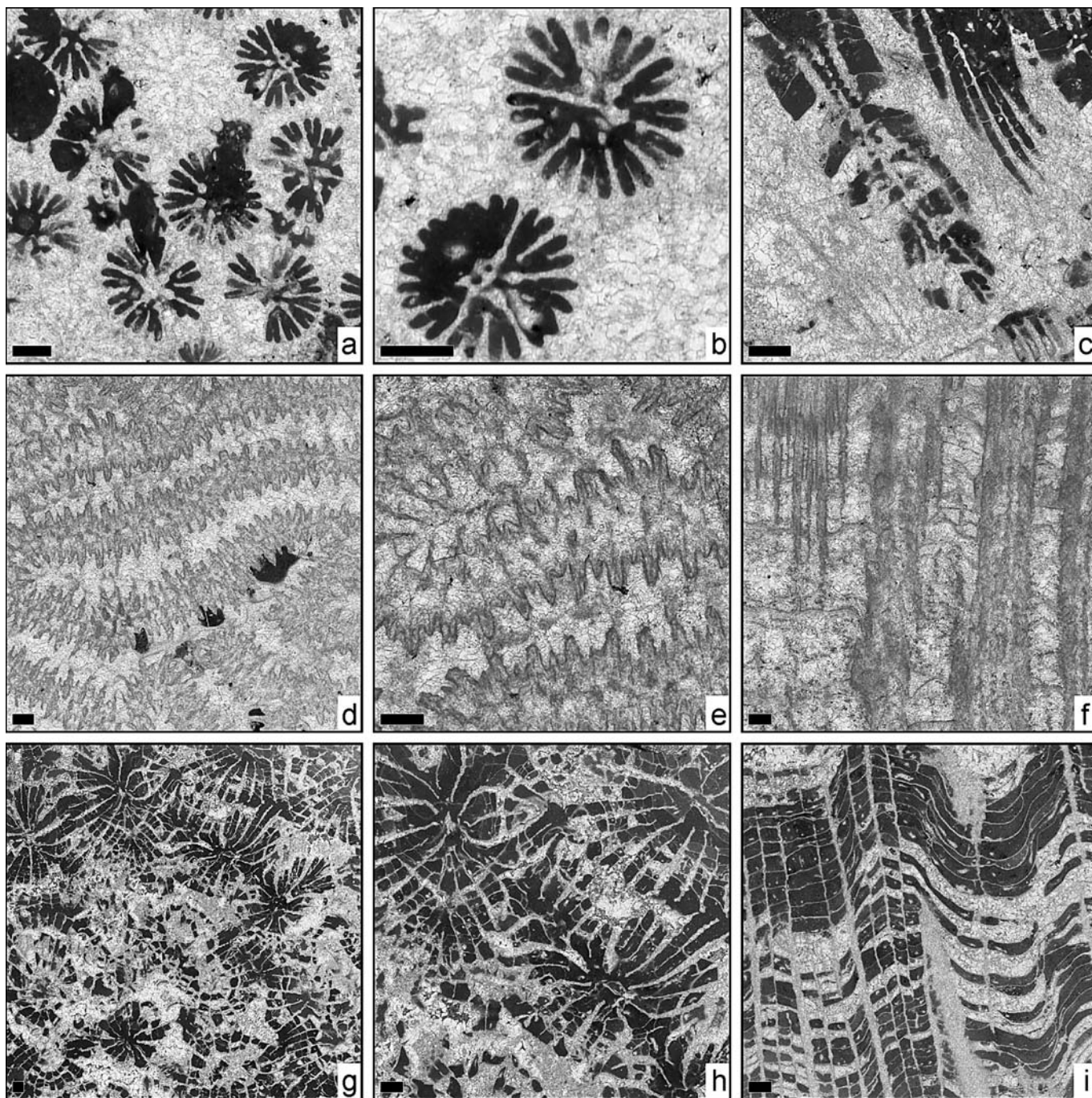
#### Dimensions.

(2014 XV 10)	n	min-max	$\mu$	s	cv	$\mu \pm s$
ccd	20	4.11-10.12	7.29	1.62	22.2	5.67-8.92
s	15	18-30	24.46	3.58	14.6	21-28
sd	9/5mm					

**Description.** Astreoid colony. Calicular outline circular to elliptical, in places arranged in rows. Septa compact. Microstructure of large trabeculae. Septa in cross section centrally thicker. Symmetry of septa irregular, but two to three size orders can be distinguished that differ in length and thickness. First septal generation reaches close to the calicular centre, later generations are shorter. Septa rarely connected to each other in the centre of the calice. Septal distal margin unknown, lateral face with vertical keels, inner margin smooth. Pali or paliform lobes absent. Septa are not attached to the columella. Costae present, non-confluent. Synapticulae absent. Columella lamellar. Endotheca consists of numerous and regular tabulae. Wall absent. Coenosteum poorly defined because of the type of the calicular arrangement. Coenosteum consists of costae and tabulae. Budding intracalicular, polystomodeal and complete.

**Remarks.** This species is the only one that could be found in all three units. Generally, the genus is very rare in the Western Tethys.





**Figure 4.** **a-c)** *Placocolumastrea gortanii* (Prever, 1909), (BSPG 2014 XV 3); **(a)** transversal thin section; **(b)** transversal thin section, detail; **(c)** longitudinal thin section. **d-f)** *Diplogyra lamellosa* Eguchi, 1936, (BSPG 2014 XV 5); **(d)** transversal thin section; **(e)** transversal thin section, detail; **(f)** longitudinal thin section. **g-i)** *Silingastraea shimoheiensis* (Eguchi, 1951), (BSPG 2014 XV 10); **(g)** transversal thin section; **(h)** transversal thin section, detail; **(i)** longitudinal thin section. Scale bar 1mm.

**Occurrence.** Sierra del Carche, Early Aptian to Late Albian, beds C1, C2, C3.

**Other occurrences.** Early Aptian of Greece (Viotía) Arachova (MB K624). Latest Aptian of Japan (Iwateken) Shimohei-gun, Taro-cho, Todana Early Cenomanian of Greece (Kozani) Kozani, Nea Nikopolis (BSPG 2003 XX 5828).

Suborder FUNGIINA Verrill, 1868-70

Family **Haplaraeidae** Vaughan & Wells, 1943

*Actinaraea* Orbigny, 1849

**Type species.** *Agaricia granulata* Münster in Goldfuss, 1829.

*Actinaraea* sp.  
(Figs 5a-c)

**Material.** BSPG 2014 XV 11; 2 thin sections.

**Dimensions.**

(2014 XV 11)	n	min-max	$\mu$	s	cv	$\mu \pm s$
ccd	7	6.16-8.29	6.95	0.69	9.9	6.25-7.64
s	6	49-64	59.33	5.92	9.9	53-65
sd	7/2mm					

**Description.** Thamnasterioid colony. Septa regularly perforated. Microstructure of large trabeculae. Septa in cross section equal in thickness in the whole septum. Symmetry of septa irregular, but septal generations that differ in length. Half of all septa extended close to the calicular centre. Septa occasionally connected to each other close to the centre of the calice. Septal distal margin coarsely granulated, lateral face with thorns, inner margin smooth. Pali or paliform lobes absent. Costae present, confluent. Synapticulae abundant. Columella poorly defined, probably represented by one isolated trabecula. Endotheca consists of few tabulae. Wall absent. Coensteum poorly defined because of the type of the calicular arrangement. Budding intracalicular, polystomodeal and complete.

**Remarks.** This specimen has - compared to known *Actinaraea* species - very large dimensions. The only specimen, even if well preserved, did not allow the creation of a new species.

**Occurrence.** Sierra del Carche, Late Albian, bed C4.

**Other occurrences.** Aptian of Mexico (Puebla) San Juan Raya, Barranca Agua del Burro (ERNO L-R11703). Early Albian of Mexico (Baja California) Santo Tomás, Arroyo de la Cueva (ERNO L-135106).

*Camptodocis* Dietrich, 1926

**Type species.** *Camptodocis brancai* Dietrich, 1926.

*Camptodocis* sp.  
(Figs 5d-f)

**Material.** BSPG 2014 XV 12 - 14; 6 thin sections.

**Synonymy.**

v 2003 *Mesomorpha ornata* Morycowa, 1971; Baron-Szabo & González León, p. 200, Fig. 5F

v 2010 *Camptodocis* cf. *basiplana* (Dietrich, 1926); Löser, p. 586, Fig. 2.7

**Dimensions.**

(2014 XV 12)	n	min-max	$\mu$	s	cv	$\mu \pm s$
ccd	15	2.25-5.01	3.77	0.80	21.3	2.97-4.58
s	10	17-22	19.40	1.71	8.8	18-21
sd	6/2mm					

**Description.** Thamnasterioid colony. Septa irregularly perforated, in cross section equal in thickness in the whole septum. Cycles of septa irregular, size orders can hardly be distinguished. Septal generations differ in length. First septal generation reaches to the centre of the calice, later generations are subsequently shorter. Septa occasionally connected to each other. Septal lateral face occasionally with granulae. Pali or paliform lobes absent. Synapticulae not very common, mainly between the calices but without forming any wall like structure. Columella small, substyliform or lamellar. Endotheca consists of numerous large and thin tabulae. Wall absent. Budding extracalicular.

**Occurrence.** Sierra del Carche, Early Aptian, bed C1.

**Other occurrences.** Barremian (Moutoniceras - Giraudi zone) of France (Drôme) Serre de Bleyton. Late Aptian of Spain (Valencia, Castellón) Benicasin, La Venta (MGSB 73704). Early Albian of Mexico (Sonora) Municipio Ures, Cerro de Oro.

Suborder HETEROCOENIINA Beauvais, 1974  
Family **Elasmocoeniidae** Duncan, 1884  
*Heteropistophyllum* Löser et al., 2013a

**Type species.** *Pseudopistophyllum quinquesseptatum* Turnšek & Buser, 1976.

*Heteropistophyllum carchensis* n.sp.  
(Figs 6a-f)

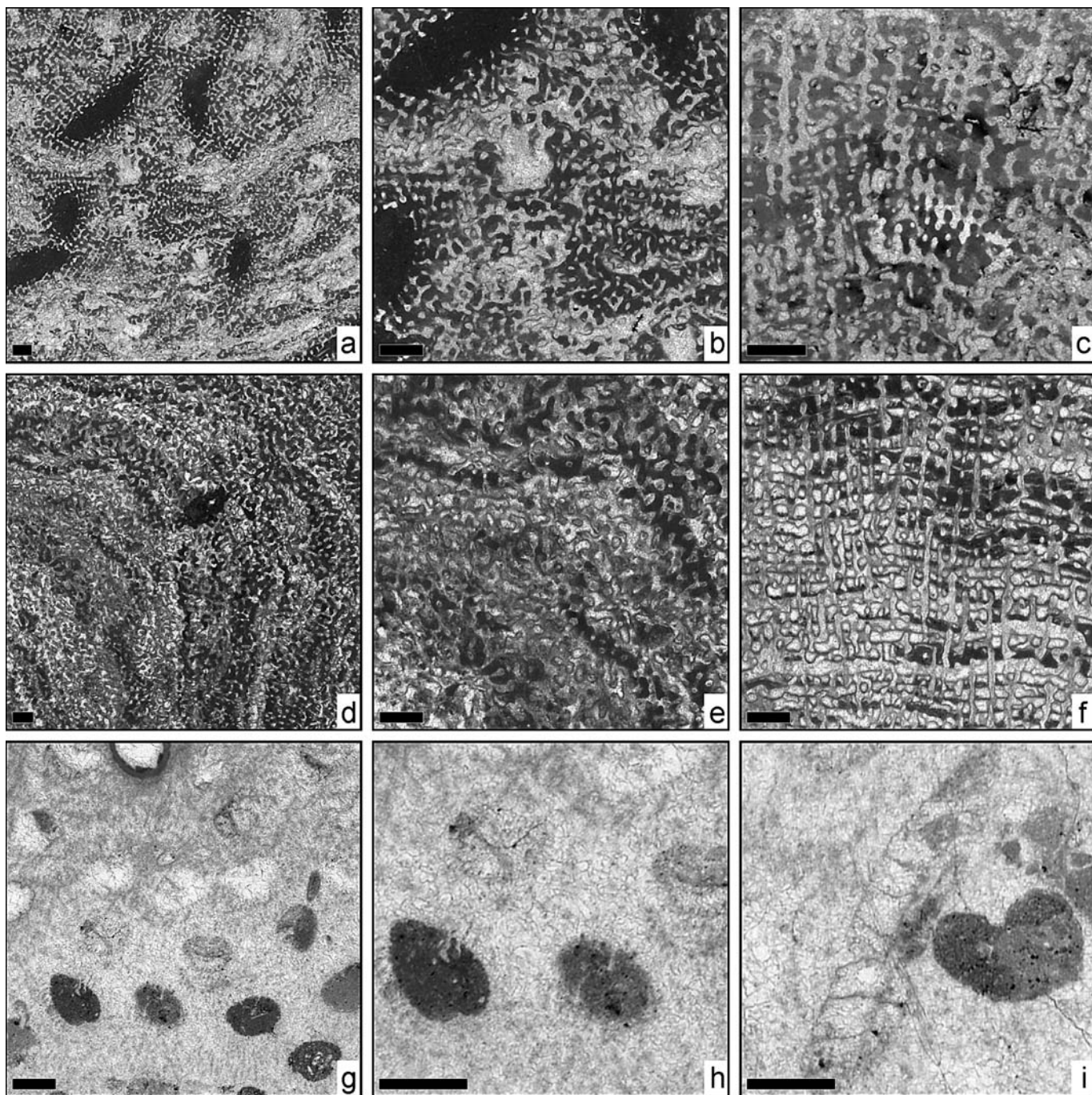
**Derivatio nominis.** After the type locality.

**Holotype.** BSPG 2014 XV 15.

**Paratypes.** BSPG 2014 XV 16, 2014 XV 17.

**Material.** Six specimens (BSPG 2014 XV 15 to 20) with 8 thin sections.

**Diagnosis.** *Heteropistophyllum* with large calices (smaller outer diameter 3.1-4.3 mm, larger outer diameter 5.9-7.1 mm), five well developed septa in the smaller



**Figure 5.** **a-c)** *Actinaraea* sp. (BSPG 2014 XV 11); **(a)** transversal thin section; **(b)** transversal thin section, detail; **(c)** longitudinal thin section. **d-f)** *Camptodocis* sp. (BSPG 2014 XV 12); **(d)** transversal thin section; **(e)** transversal thin section, detail; **(f)** longitudinal thin section. **g-i)** *Pleurocoenia aprutina* (Prever, 1909), (BSPG 2014 XV 21); **(g)** transversal thin section; **(h)** transversal thin section, detail; **(i)** longitudinal thin section. Scale bar 1mm.

face of the calice, and only septal spines in the larger face of the calice.

**Locus typicus.** Spain, Murcia, Sierra del Carche, bed C2; 38°26'0"N 1°10'39.6"W (WGS 84).

**Stratum typicum.** Early Late Aptian.

**Comparison.** The new species differs from the other known species (*H. quinqueseptata* Turnšek & Buser, 1976, *H. triseptum* Kolodziej *et al.* 2012) by its large calicular dimensions. *H. triseptum* shows moreover only three septa.

**Remarks.** Within the study area, the new species is restricted to one bank, but is common within this bank.

Apart from this, the new species was only found in the Early Albian of Sonora (Northern Mexico).

#### Dimensions.

(2014 XV 15)	n	min-max	$\mu$	s	cv	$\mu \pm s$
cl min	17	1.52-2.42	1.96	0.30	15.6	1.66-2.27
cl max	17	3.44-4.89	4.22	0.41	9.8	3.81-4.64
cmin	20	2.83-5.02	3.68	0.63	17.2	3.05-4.32
cmax	20	5.18-7.34	6.45	0.59	9.2	5.85-7.05
s	5					

**Description.** Phaceloid colony. Calicular outline kidney or bean shaped. Septa compact. Symmetry of septa bilateral. General five large septa are located in the smaller face of the calice. They are in cross section thick close to the wall, thinner towards the centre, reaching 60 % of the calicular diameter, and not being connected to each other. Septal distal margin unknown, lateral face with thorns, inner margin slightly swollen in places. Opposite septa are only present as very fine thorns. Pali or paliform lobes, costae, synapticalae and columella absent. Endotheca consists of very few tabulae. Wall thick and compact, probably trabecular. Coenosteum absent. Budding intracalicular, marginal.

**Occurrence.** Sierra del Carche, Early Late Aptian, bed C2.

**Other occurrences.** Early Albian of Mexico (Sonora) Municipio Arizpe, Arizpe, Cerro La Ceja (ERNO L-4266), Municipio Cucurpe, Cucurpe, La Mesa (ERNO L-4282).

*Pleurocoenia* Orbigny, 1849

**Type species.** *Pleurocoenia provincialis* Orbigny, 1849.

**Remarks.** *Pleurocoenia* differs from *Latusastrea* Orbigny, 1849 by a reduced coenosteum, only one (rarely three) main septa and secondary septa reduced to spines. Moreover, the calicular dimensions of *Pleurocoenia* are much smaller than in *Latusastrea*. *Latusastrea* ranges from the Late Jurassic into the Early Albian; *Pleurocoenia* ranges from the Hauterivian to the Turonian.

*Pleurocoenia aprutina* (Prever, 1909)  
(Figs 5g-i)

**Material.** BSPG 2014 XV 21; 2 thin sections.

#### Synonymy.

\*v 1909 *Heliopora aprutina*; Prever, p. 65, Pl. 27, Fig. 1

v 1964 *Latusastraea provincialis* (Orbigny, 1850); Morycowa, p. 70, Pl. 19, Fig. 3, Pl. 20, Fig. 4

1993 *Latusastraea decipiens* Prever 1909; Baron-Szabo, p. 157, Pl. 2, Fig. 4

1995 *Latusastraea exiguis* (Fromentel, 1862); Morycowa, Decrouez & Schenk, p. 18, Figs. 1, 2, 3 a-f  
v 1997 *Pleurocora* sp.; Baron-Szabo, p. 77

v 2006 *Latusastrea* cf. *provincialis* (Orbigny, 1849); Löser & Ferry, p. 480, Figs. 4.6, 4.7

#### Dimensions.

(2014 XV 21)	n	min-max	$\mu$	s	cv	$\mu \pm s$
cl min	20	0.80-0.96	0.88	0.04	5.3	0.83-0.92
cl max	20	0.93-1.55	1.22	0.14	11.7	1.07-1.36
ccd	20	1.47-2.24	1.82	0.25	13.8	1.57-2.07

**Description.** Plocoid colony. Calicular outline elliptical. Symmetry of septa bilateral. Main septum in cross section equal in thickness in the whole septum. Septal lateral face occasionally with thorns, inner margin slightly swollen in places. Secondary septa as fine and very short thorns. Pali or paliform lobes, costae, synapticalae, columella absent. Endotheca consists of tabulae. Wall compact, probably trabecular. Coenosteum medium broad, trabecular. Budding extracalicular.

**Occurrence.** Sierra del Carche, Early Aptian, bed C1.

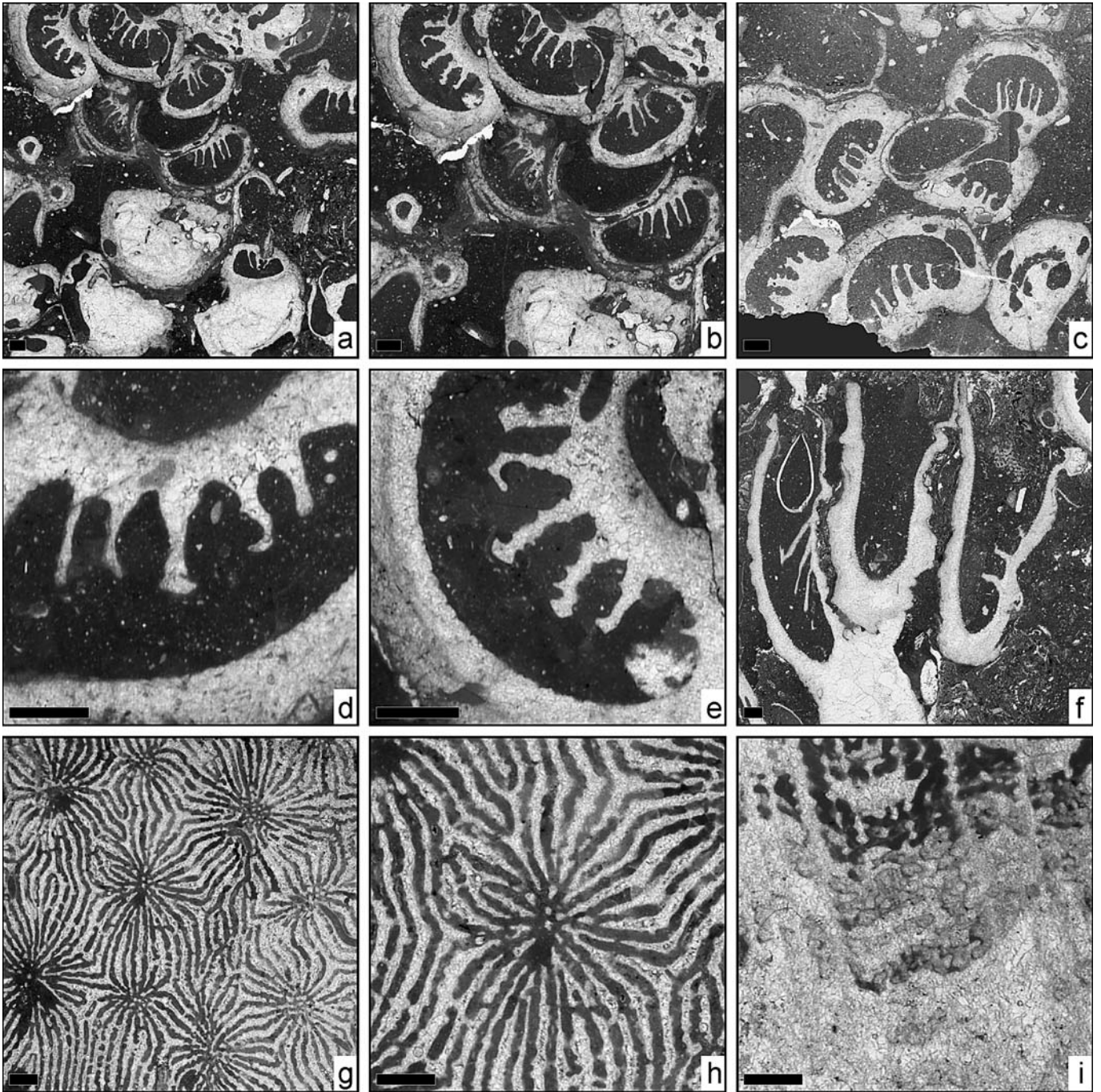
**Other occurrences.** Late Barremian of France (Ardèche) St.Remèze, Belvédère du Serre-de-Tourre. Late Barremian to Early Aptian of Switzerland (Bern) Rawil pass. Aptian of Mexico (Puebla) Tehuacán, Barranco San Lucas (ERNO L-7116). Early Aptian (Tuarkyricus - Weissi zone) of France (Vaucluse) Sault (FSL R72). Early Aptian of Greece (Viotia) Levadia, Perachorion (BSPG 2003 XX 5775). Italy (Abruzzi, L'Aquila) Monti d'Ocre. Poland (Malopolskie, Wadowice) Lanckorona, Jastrzebia (ERNO L-5427). Latest Aptian to Early Albian of Spain (Vascongadas, Vizcaya) Gamecho, Playa de Laga. Early Albian of Mexico (Sonora) Municipio Opodepe, Tuape, Cerro de la Espina (ERNO L-4459). Late Turonian to Early Coniacian of Austria (Tirol) Brandenberg, Haidach.

Suborder MICROSOLENINA Morycowa & Roniewicz, 1995

Family **Leptophylliidae** Vaughan, 1905

*Astraeofungia* Alloiteau, 1952





**Figure 6.** **a-f)** *Heteropistophyllum carchensis* n. sp. (BSPG 2014 XV 15, holotype); **(a)** transversal thin section; **(b-e)** transversal thin section, detail; **(f)** longitudinal thin section. **g-i)** *Astraeofungia* sp. (BSPG 2014 XV 25); **(g)** transversal thin section; **(h)** transversal thin section, detail; **(i)** longitudinal thin section. Scale bar 1mm.

**Type species.** *Astrea decipiens* Michelin, 1841.

**Dimensions.**

*Astraeofungia* sp.  
(Figs 6g-i)

(2014 XV 25)	n	min-max	$\mu$	s	cv	$\mu \pm s$
ccd	25	3.07-4.47	3.73	0.41	11.1	3.31-4.14
s	10	22-45	32.70	6.53	19.9	26-39
sd	8/2.5mm					

**Material.** BSPG 2014 XV 22 - 25; 4 thin sections.

**Description.** Thamnasterioid colony. Septa perforated at their inner margin. Microstructure of large trabeculae. Septa in cross section thick close to the wall, thinner towards the centre. Symmetry of septa irregular. Half of all septa extended close to the calicular centre. Septa often connected to each other close to the centre of the calice. Septal distal margin unknown, lateral face with pennulae and thorns, inner margin smooth. Pali or paliform lobes absent. Costae present, confluent or sub-confluent. Synapticulae occasional, mainly in the space between calices. Columella composed of a group of isolated trabeculae. Endotheca consists of few thin tabulae. Wall absent. Coenosteum poorly defined because of the type of the calicular arrangement. Budding extracalicular.

**Remarks.** The material is only comparable to the Late Jurassic *Thamnasteria huzimotoi* Eguchi, 1951.

**Occurrence.** Sierra del Carche, Late Albian, bed C3, C4.

**Other occurrences.** Early Albian (Tardefurcata zone) of Spain (Cataluña, Barcelona) Com. Alt Penedès, Castellvi de la Marca, Can Pascual (BSPG 2003 XX 6284). Early Late Albian (Inflatum zone) of Spain (Valencia, Alicante) Sierra de Llorençá (MGSB 74365). Middle to Late Cenomanian (Rhotomagense - Naviculare zone) of France (Sarthe) Le Mans (MB K3241.2).

*Dimorphastrea* Orbigny, 1850

**Type species.** *Dimorphastrea grandiflora* Orbigny, 1850.

*Dimorphastrea* sp.  
(Figs 7a-c)

**Material.** BSPG 2014 XV 26 - 28; 2 thin sections.

**Synonymy.**

v 2013c *Dimorphastrea regularis* (de Fromentel, 1857); Löser *et al.*, p. 60, Pl. 6, Figs. 5, 6

**Dimensions.**

(2014 XV 28)	n	min-max	$\mu$	s	cv	$\mu \pm s$
crd	4	3.84-5.46	4.61	0.70	15.3	3.90-5.32
cdw	10	1.96-3.90	2.82	0.55	19.5	2.27-3.37
s	10	26-35	30.70	3.09	10.0	28-34
sd	8/2.5mm					

**Description.** Thamnasterioid colony with calices arranged in regular rows. Septa perforated at their inner margin. Microstructure of large trabeculae. Septa in cross section thick close to the wall, thinner towards the centre. Symmetry of septa irregular. Half of all septa extended close to the calicular centre. Septa occasionally connected to each other close to the centre of the calice. Septal distal margin unknown, lateral face with pennulae and thorns, inner margin smooth. Pali or paliform lobes absent. Costae present, confluent. Synapticulae occasional, mainly in the space between the calicular centres. Columella composed of a group of isolated trabeculae. Endotheca consists of thin tabulae. Wall absent. Coenosteum poorly defined because of the type of the calicular arrangement. Budding extracalicular.

**Occurrence.** Sierra del Carche, Late Albian, bed C4.

**Other occurrences.** Early Cenomanian (Dixon zone) of Germany (Sachsen) Meißen-Zscheila, Trinitatis church (SNSD-MMG SaKL 362). Middle Cenomanian of Germany (Bayern) Roßstein-Almen. Late Cenomanian (Plenus zone) of Germany (Sachsen) Dresden-Plauen, Ratssteinbruch (ERNO L-6137).

*Ovalastrea* Orbigny, 1849

**Type species.** *Astrea caryophylloides* Goldfuss, 1826.

*Ovalastrea picteti* (Koby, 1897)  
(Figs 7d-f)

**Material.** BSPG 2014 XV 29 - 31; 4 thin sections.

**Synonymy.**

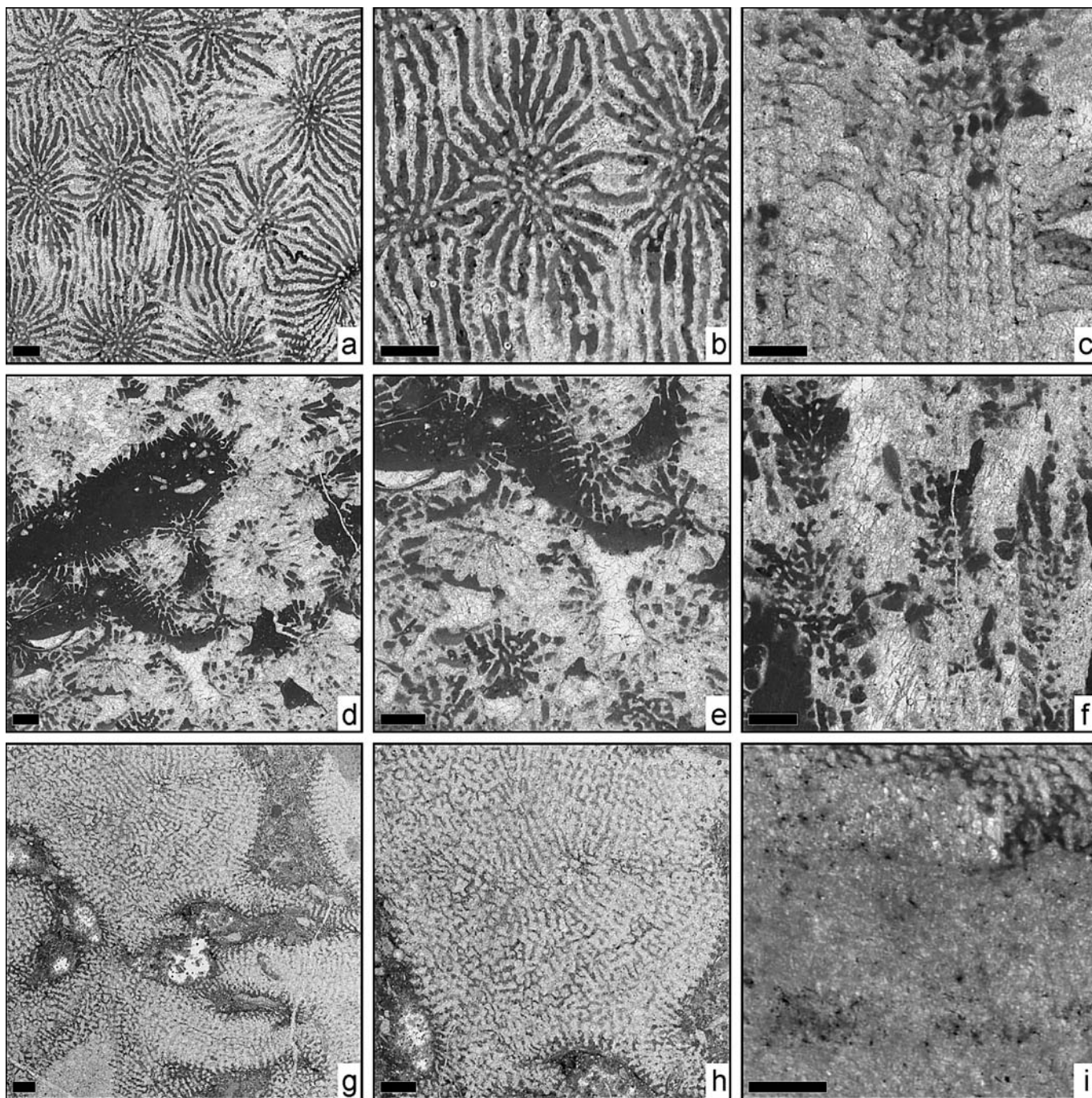
\*v 1897 *Phyllocoenia* ? *Picteti*; Koby, p. 34, Pl. 10, Fig. 9, 10

v 1951 *Montastrea nipponica* Eguchi, n.sp.; Eguchi, p. 25, Pl. 5, Fig. 4, 5

v 2013a *Ovalastrea picteti* (Koby 1897); Löser *et al.*, p. 25, Pl. 8, Fig. 4-6

**Dimensions.**

(2014 XV 29)	n	min-max	$\mu$	s	cv	$\mu \pm s$
cl min	10	1.41-2.09	1.77	0.23	13.1	1.53-2.00
cl max	10	1.76-2.71	2.30	0.29	13.0	2.00-2.60
ccd	10	2.40-3.49	2.81	0.33	11.9	2.47-3.15
s	5	31-39	34.0	3.0	8.8	31-37



**Figure 7.** a-c) *Dimorphastrea* sp. (BSPG 2014 XV 26); (a) transversal thin section; (b) transversal thin section, detail; (c) longitudinal thin section. d-f) *Ovalastrea picteti* (Koby, 1897), (BSPG 2014 XV 29); (d) transversal thin section; (e) transversal thin section, detail; (f) longitudinal thin section. g-i) *Dimorpharaea* sp. (BSPG 2014 XV 32); (g) transversal thin section; (h) transversal thin section, detail; (i) longitudinal thin section. Scale bar 1mm.

**Description.** Plocoid colony. Calicular outline circular to elliptical. Septa perforated at their inner margin, in cross section slightly thicker close to the wall, becoming slightly thinner towards the centre. Symmetry of septa irregularly radial, but size orders can be distinguished that differs more by length than by thickness. Half of all septa extended to the calicular centre. Septa occasionally connected to each other close to the centre of the calice. Septal distal

margin unknown, lateral face with pennulae and thorns, inner margin smooth. Pali or paliform lobes absent. Costae present, sub-confluent to non-confluent. Synapticulae present, occasional, mainly in the space between calices. Columella composed of isolated trabeculae or one more solid element. Endotheca consists of thin tabulae. Wall subcompact, parathecal. Coenosteum medium broad, consists of costae. Budding extracalicular.

**Occurrence.** Sierra del Carche, Late Albian, bed C3.

**Other occurrences.** Barremian of France (Doubs) Morteau. Late Aptian of Japan (Iwate-ken) Miyako-shi, Sakiyama, Hideshima and Shimohei-gun, Tanohata-mura, Haipe (TUM 59183). Early Late Albian (Inflatum zone) of Spain (Valencia, Alicante) Sierra de Llorençà.

Family **Microsolenidae** Duncan, 1884  
*Dimorpharaea* de Fromentel, 1861

**Type species.** *Microsolena koechlini* Milne Edwards, 1860.

*Dimorpharaea* sp.  
(Figs 7g-i)

**Material.** BSPG 2014 XV 32; 2 thin sections.

#### Dimensions.

(2014 XV 32)	
crd	1.9-2.1
cdw	1.5-2.3
s	15-16
sd	8/2mm

**Description.** Thamnasterioid colony with calices arranged in rows. Septa regularly perforated. Microstructure of large trabeculae. Septa in cross section equal in thickness in the whole septum. No septal symmetry. Half of all septa extended to the calicular centre. Septa occasionally connected to each other close to the centre of the calice. Septal distal margin with large regular granules, lateral face with pennulae, inner margin smooth. Pali or paliform lobes absent. Costae present, confluent, with thick granules on their surface. Synapticulae present, abundant. Columella small, substyliiform. Endotheca unknown. Wall absent. Coenosteum poorly defined because of the type of the calicular arrangement. Budding intracalicular, polystomodeal and complete.

**Remarks.** This material is very questionable and may be also related to *Comoseris*, *Eocomoseris* and *Maeandraraea*.

**Occurrence.** Sierra del Carche, Early Aptian, bed C1.

Suborder **STYLININA** Alloiteau, 1952  
Family **Cyathophoridae** Duncan, 1884  
*Cryptocoenia* Orbigny, 1849

**Type species.** *Astrea alveolata* Goldfuss, 1826.

*Cryptocoenia almerai* (d'Angelis d'Ossat, 1905)  
(Figs 8a-c)

**Material.** BSPG 2014 XV 33; 1 thin section.

#### Synonymy.

v 1884 *Columnastraea* cf. *striata* Gldf. sp.; Toula, p. 1317, Pl. 6, Fig. 5

v 2013 *Cryptocoenia almerai* (d'Angelis d'Ossat, 1905); Löser, p. 31, Fig. 10l [here more detailed synonymy and occurrence data]

#### Dimensions.

(2014 XV 33)	n	min-max	$\mu$	s	cv	$\mu \pm s$
cl	9	1.04-1.43	1.23	0.15	12.2	1.08-1.38
s	6+6					

**Description.** Plocoid colony. Calicular outline circular. Septa compact. Symmetry of septa radial and regularly hexameral. Cycles of septa subregular. Septal cycles differ in length. Septa short, not connected to each other. Septal lateral face smooth, inner margin smooth. Pali or paliform lobes absent. Costae unknown. Synapticulae and columella absent. Endotheca consists of tabulae. Wall compact, probably parathecal. Coenosteum narrow, consists of costae and tabulae. Budding extracalicular.

**Occurrence.** Sierra del Carche, Late Albian, bed C4.

**Other occurrences.** See Löser (2013).

*Cryptocoenia* sp.  
(Figs 8d-f)

**Material.** BSPG 2014 XV 34, 35; 3 thin sections.

#### Synonymy.

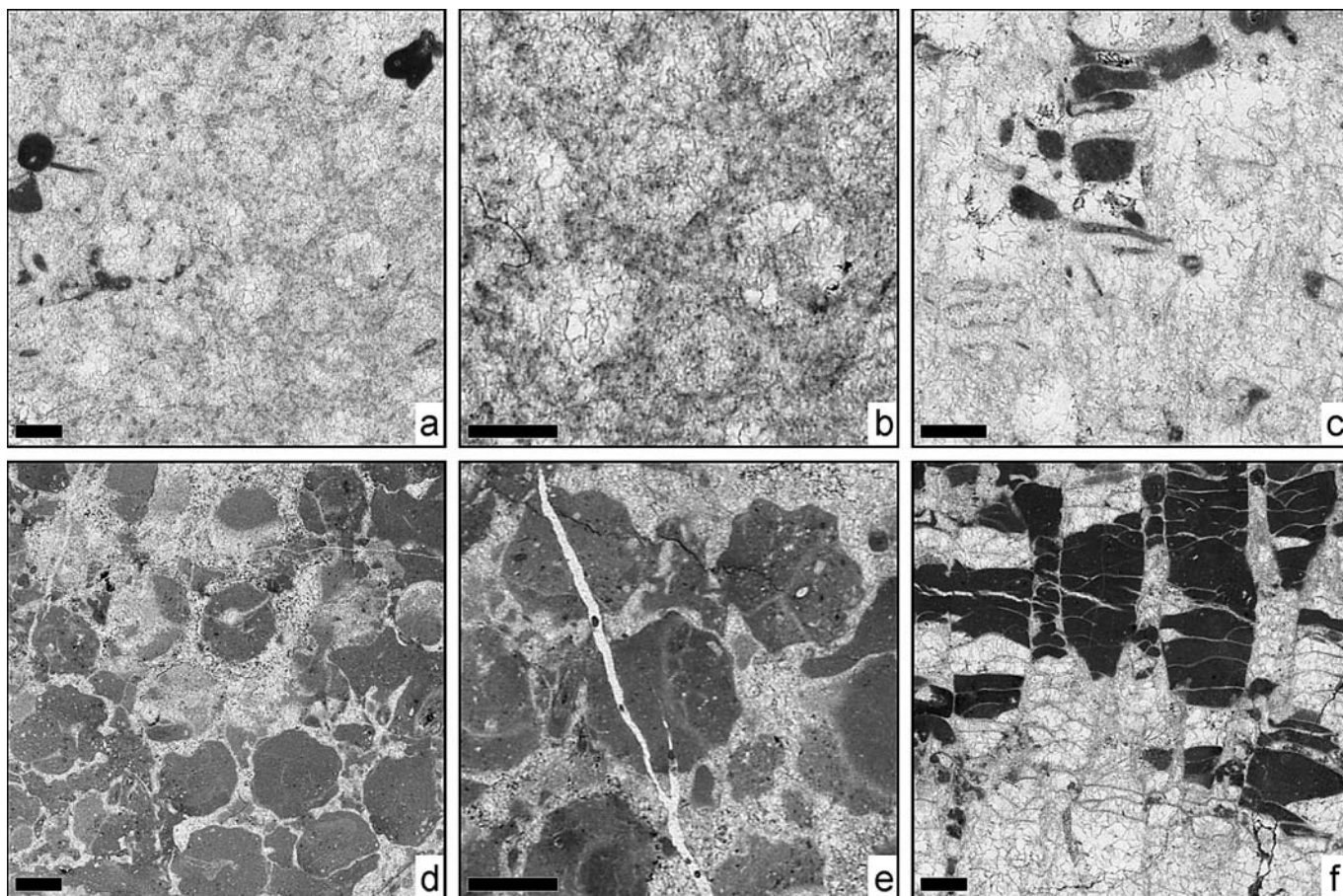
v 1996 *Heterocoenia* sp.; Baron-Szabo & Steuber, p. 18

#### Dimensions.

(2014 XV 35)	n	min-max	$\mu$	s	cv	$\mu \pm s$
cl	30	1.25-1.81	1.48	0.14	9.7	1.34-1.62
ccd	30	1.59-2.40	2.01	0.21	10.6	1.79-2.22
s	6					

**Description.** Plocoid colony. Calicular outline circular. Septa compact. Symmetry of septa radial and regularly hexameral. Cycles of septa subregular. Septal cycles differ in length. Septa short, not connected to each other. Septal lateral face smooth, inner margin smooth. Pali or paliform lobes absent. Costae present, confluent or sub-confluent.





**Figure 8.** **a-c)** *Cryptocoenia almerai* (d'Angelis d'Ossat, 1905), (BSPG 2014 XV 33); **(a)** transversal thin section; **(b)** transversal thin section, detail; **(c)** longitudinal thin section. **d-f)** *Cryptocoenia* sp. (BSPG 2014 XV 35); **(d)** transversal thin section; **(e)** transversal thin section, detail; **(f)** longitudinal thin section. Scale bar 1mm.

Synapticulae and columella absent. Endotheca consists of regular tabulae and occasional dissepiments. Wall compact, parathecal. Coenosteum narrow, consists of costae and tabulae. Budding extracalicular.

**Remarks.** This species differs from *C. almerai* by larger calicular dimensions and only six septa.

**Occurrence.** Sierra del Carche, Late Albian, bed C4.

**Other occurrences.** Early Aptian of Greece (Viotia) Arachova; Levadia, Perachorion (BSPG 2003 XX 5768). Aptian to Early Albian of Japan (Iwate-ken) Miyakoshi, Sakiyama, Hideshima (TUM L-NN-10). Late Aptian of Japan (Miyagi-ken) (TUM L-NN-9). Early Albian of Mexico (Sonora) Municipio Cucurpe, Cucurpe, La Mesa (ERNO L-4283) and Municipio Opodepe, Tuape, Cerro de la Espina (ERNO L-4260). Early Cenomanian of Greece (Kozani) Kozani, Nea Nikopolis (ERNO L-5883).

Family **Stylinidae** Orbigny, 1851  
*Stylina* Lamarck, 1816

**Type species.** *Stylina echinulata* Lamarck, 1816.

*Stylina inwaldensis* (Ogilvie, 1897)  
(Figs 3h-i)

**Material.** BSPG 2014 XV 36; 1 thin section.

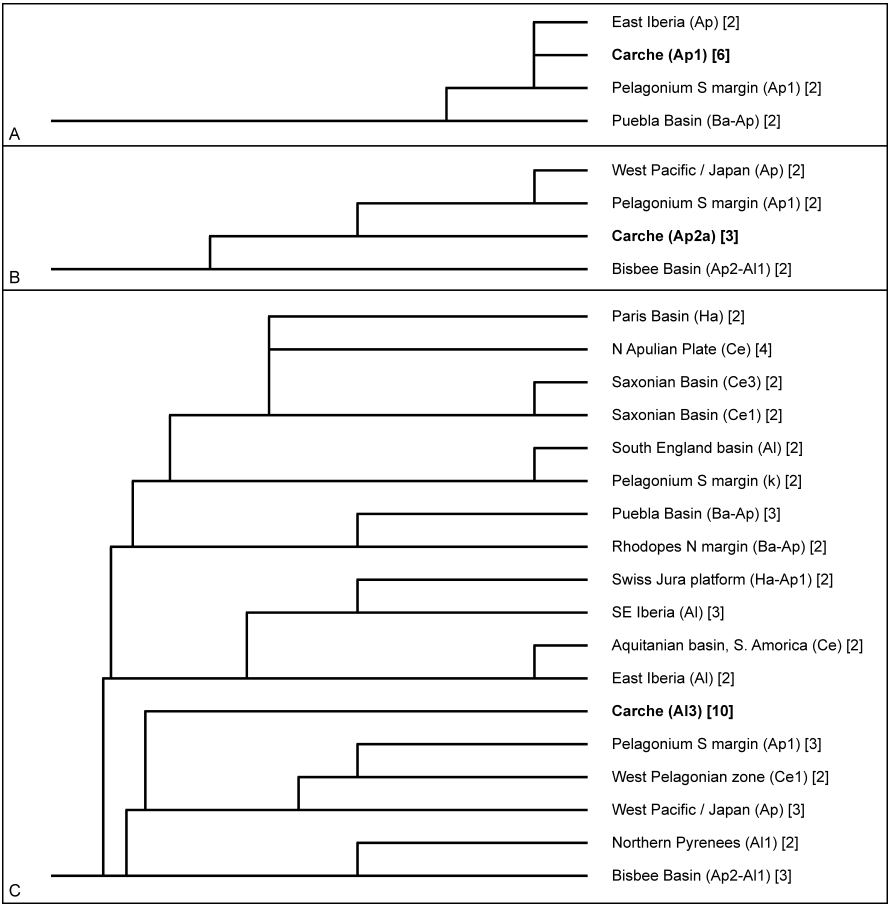
**Synonymy.**

v 1897 *Diplocoenia inwaldiensis*; Ogilvie, p. 165, Pl. 18, Figs. 7, 8

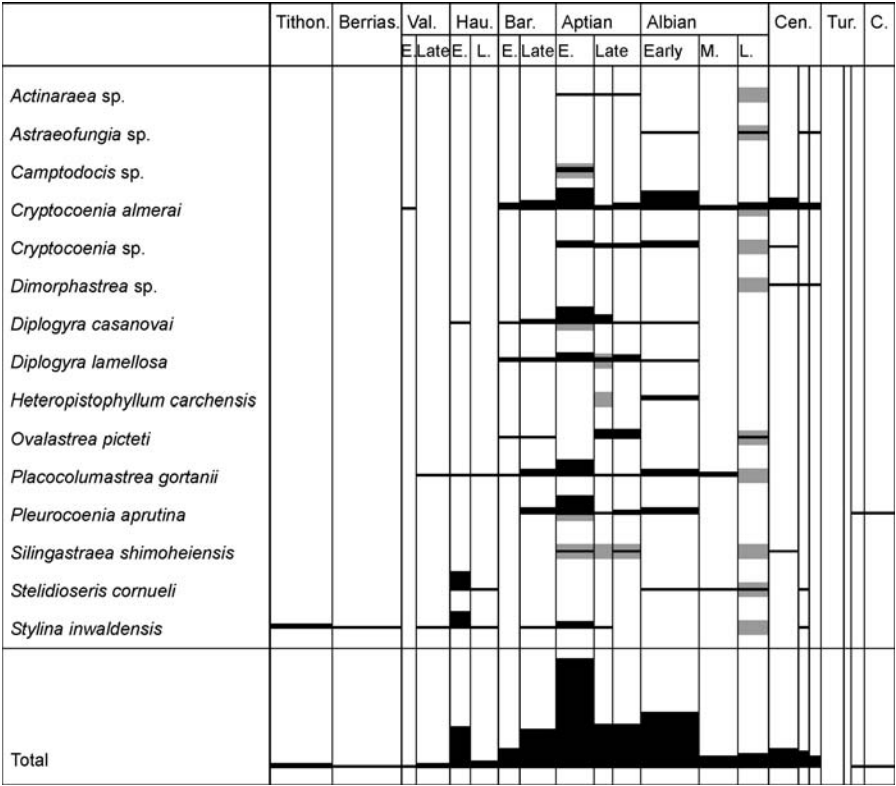
v 2013c *Stylina inwaldiensis* (Ogilvie, 1897); Löser et al., p. 66, Pl. 9, Figs. 10-12 [here more detailed synonymy and occurrence data]

**Dimensions.**

(2014 XV 36)	n	min-max	$\mu$	s	cv	$\mu \pm s$
cl	30	0.93-1.19	1.07	0.06	5.9	1.01-1.13
ccd	30	1.18-1.94	1.61	0.17	10.6	1.43-1.78
s	8+8					



**Figure 9.** Correlation of faunules with joint species of the three coral bearing levels. Faunules with less than two joint species are omitted. Species number in brackets. The Correlation Ratio coefficient was applied. For details of calculation see Löser & Minor (2007). A, Early Aptian; B, Late Aptian; C, Late Albian.



**Figure 10.** Stratigraphic distribution and commonness of species of the studied faunas. The thickness of the bars indicates the number of localities in which the species concerned was found until present. Grey bar indicates age level of the corresponding faunas. Below, the distributions are summarized. Ranges based on Löser *et al.* (2002, 2005); localities with a range longer than 13.3 ma are omitted from calculations, as well as localities with an uncertain stratigraphy.

**Description.** Plocoid colony. Calicular outline circular. Septa compact, in cross section thin in the whole septum. Symmetry of septa radial and irregularly octameral. Cycles of septa subregular. Septal cycles differ in length and thickness. First septal cycle reaches 35 % of the calicular diameter, those of the second cycle are shorter. Septa not connected to each other. Septal distal margin unknown, lateral face smooth (probably due to preservation), inner margin with auriculae. Pali or paliform lobes absent. Costae unknown. Synapticulae absent. Columella styliform. Endotheca unknown. Wall compact, probably parathecal. Coenosteum narrow. Constitution of the coenosteum unknown. Budding extracalicular.

**Remarks.** *Stylina inwaldiensis* is a very common species and has a very long range. It is found from the Latest Jurassic, throughout the whole Early Cretaceous, and in the Late Cretaceous up to the Middle Cenomanian.

**Occurrence.** Sierra del Carche, Late Albian, bed C4.

**Other occurrences.** See Löser *et al.* (2013c).

## 5. DISCUSSION

The three levels with corals have yielded comparably species-poor faunas. A sample bias can be excluded since a high amount of material was collected, but a conservation bias may have had a considerable influence on the final faunal list. Nevertheless, conservation is always a problem in Cretaceous coral faunas. The original aragonite skeletons always experience loss in quality during the diagenetic process, less if the pH of the sediments is high (marls as in the Gosau area, Austria, or ophiolitic conglomerates as in Greece and the Arabian Peninsula), more if the pH is low (e.g., pure carbonate rocks). The three faunas encompass typical Cretaceous coral genera. There are very common genera such as *Astraeofungia*, *Cryptocoenia*, *Diplogyra*, *Dimorpharaea*, *Dimorphastrea*, *Ovalastrea*, *Placocolumastrea*, *Stelidioseria*, less common genera (*Actinaraea*, *Amphiastrea*, *Camptodocis*, *Pleurocoenia*, *Stylina*) and two rather rare genera (*Heteropistophyllum*, *Silingastraera*). Particularly, the rare genera were already found in the Prebetic in other localities (Löser *et al.*, 2013a). The distribution among Scleractinian suborders is comparable to other faunas (see for instance Löser, 2013): Faviina and Microsolenina are dominating, Archeoceniina, Fungiina, Heterocoeniina, and Stylinina are subordinated, because they have simply less genera in the Cretaceous.

The three levels share only two genera (*Diplogyra* in C1 and C2; *Silingastraera* in all levels), although all genera (except for *Amphiastrea* that has its last occurrence in the

Early Aptian) has long ranges and are all present in the observed time span. The three coral faunas are small and therefore make a palaeobiogeographical comparison with other faunas difficult (Fig. 9). It is surprising that most correlating faunules have almost the same age as the observed Aptian faunas (Figs 9A-B). The more species-rich Late Albian fauna shows also relationships to some Early Cretaceous faunules, but strong relationships to other Albian and to Cenomanian faunas (Fig. 9C). Most species do not experience range extensions (Fig. 10); only *Actinaraea* sp., and *Placocolumastrea gortanii*. All other species are known either from localities of the same age or younger and older sediments. The latter is mostly the case for the Late Albian fauna. Late Albian coral faunas are very poorly reported on a global scale and their faunal inventory is not well known (see Löser *et al.*, 2013a for discussion). The total distribution pattern for all species corresponds of course to the global coral diversity (Löser *et al.*, 2013a, Fig. 1); a very high diversity in the Early Aptian and a stepwise decrease from the Late Aptian on.

## ACKNOWLEDGEMENTS

We would like to thank Jean-Pierre Masse (Marseille) for his help in fossil determination that assisted much to precise the stratigraphy. Financial support for sample preparation by UNAM/DGAPA PAPIIT project IN101111 for HL is greatly acknowledged. Additional thin sections were prepared in the ERNO laboratory by Aimee Orcí (Hermosillo, Sonora, Mexico). Reviews by Francisco Sánchez-Beristáin (Mexico City) and D.G. Pandey (Jaipur) helped to improve the article. Grammatical correction was undertaken by Matthew Copley (Kingston, Surrey, UK).

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